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FOREST PLANTING IN EASTERN NEBRASKA.

By
FRANK G. MILLER, M. F.,
FOREST ASSISTANT, FOREST SERVICE.

ORGANIZATION OF THE FOREST SERVICE.

GIFFORD PINCHOT, *Forester.*

OVERTON W. PRICE, *Associate Forester.*

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FOREST PLANTING IN EASTERN NEBRASKA.

PURPOSE OF THE STUDY.

The study of forest plantations in eastern Nebraska upon which this report is based was made to ascertain the tree species best suited for planting in the region. To this end the species planted in the past were studied with reference to their silvical requirements, notes were made on the effect of different methods of planting, and typical plantations were measured to find the amount and value of the product.

THE REGION.

The region covered by this report includes that part of Nebraska east of the ninety-ninth meridian.

TOPOGRAPHY, DRAINAGE, SOIL.

Eastern Nebraska is a broad plateau sloping gently from the west toward the Missouri River. The surface is diversified by many valleys and by large areas of bottomland. Away from the streams the topography is often marked by rolling hills and steep slopes.

The entire region is drained by numerous small streams flowing into the Niobrara, Elkhorn, Platte, and Nemaha rivers, which, in turn, are tributary to the Missouri.

The soil is well adapted to tree growth. For the most part it is a loess—that is, a fine sandy loam—mixt with a large quantity of silt and more or less calcareous matter. This absorbs water readily and retains it for long periods, especially where surface cultivation is given.

Toward the sand hills the soil supports practically no natural forest growth, and the little tree planting done is confined chiefly to the valleys. Recent experiments, however, have demonstrated that some species of pine can be planted successfully on the sand hills proper.

CLIMATE.

The region is characterized by rather severe winters and warm summers, sudden and extreme changes of temperature, wide seasonal and yearly deviation in precipitation, a clear, pure, moderately dry atmosphere, and a high percentage of sunshine.

The prevailing winds are from the south and southeast during the spring and summer and from the northwest in fall and winter. Their average velocity is high. The southerly winds of summer frequently come as hot waves, which, by causing excessive transpiration, injure tree growth. Moreover, the strong northwest winds of winter are more injurious to trees than is commonly supposed. Transpiration goes on at all seasons, and since the northerly winds blow when the ground is frozen, the trees are unable to secure the soil water and suffer or even die from drought as certainly as in summer.

Occasional prolonged hot or cold periods occur, which are a very severe test to trees, and species which have been introduced from other localities sometimes die. In the unusually cold winter of 1898–99, for example, a large percentage of the Osage orange hedges were killed, not only in Nebraska, but thruout the central Mississippi Valley.

PRECIPITATION.

The following table shows for eastern Nebraska the total annual precipitation, the total for the growing season, and the ratio of the seasonal to the annual rainfall:

Station.	Elevation.	Period of observation.	Average annual precipitation.	Precipitation during growing season.	
				April to August, inclusive.	Ratio to annual precipitation.
	Feet.	*Years.*	*Inches.*	*Inches.*	*Per cent.*
Omaha	1,040	27	31.4	20.8	66
Desoto	1,100	24	29.6	19.3	65
Genoa	1,585	21	26.8	17.9	67
North Platte	2,809	29	18.1	13.4	74
Yankton, S. Dak	1,206	20	25.8	17.9	69

Altho the average annual precipitation for Nebraska for the period from 1876 to 1904 was but 23.57 inches, the above table shows that more than two-thirds of the total falls during the growing season, thus giving the State a very favorable showing against States farther east, where the total annual rainfall is considerably greater but more equally distributed thru the different seasons. This fact explains, in large measure, the success which has attended tree planting.

On the other hand, the wide deviation in the amount of precipitation from year to year is a factor which tends to restrict the number of species that can safely be recommended. For example, the precipitation in 1881 was 30.91 inches. In 1893 the precipitation was only 16.18 inches, and the years 1894 and 1895 also experienced a shortage in rainfall, making three consecutive dry years. This period was very severe on planted timber, and some species proved unadapted to certain localities or situations where they hitherto had been successful.

Much of the cottonwood and willow, for example, which had done well for several years on the upland, was either badly injured or killed. Thus it is clear that in selecting a species for a given locality, not only the average but the extremes of weather conditions must be taken into account.

FOREST PLANTING OF THE PAST.

Nebraska is essentially a prairie State. Only about 3 per cent of the total area was originally covered with natural timber, and nowhere was the forest area large. Even in the eastern counties, where the greatest amount of timber is found, probably less than 10 per cent of the area was originally occupied by forest. The scarcity of natural timber, together with the character of the climate, has led to an unusual amount of forest planting. The average of the figures returned by the assessors for 1903 and 1904 shows that the entire State has 286,000 acres of planted timber. Of this amount, about 248,000 acres, or nearly 87 per cent, is in the territory east of the ninety-ninth meridian.

The object in past planting was primarily to secure protection against the storms and winds that so frequently visit Nebraska prairies. Its commercial side was considered only incidentally. The tendency, therefore, was to select the quick-growing species, especially those near at hand, which could be had cheaply. Tho there has been a comparatively large amount of planting done, the major part is in poor condition to-day. This may be accounted for in several ways. The trees chosen were often ill adapted to the conditions. Thus it frequently happened that a species adapted primarily to the bottomland soils was planted indiscriminately on the uplands, or that a species was planted on sandy land which could succeed only in a loam with a clay subsoil. Still another cause of failure has been lack of care and management. There is scarcely a plantations in Nebraska which has been managed with the same care that the enterprising farmer gives to his field crops. Instead, the vast majority of plantations have had little care or none at all. Almost invariably they have been made free range for live stock. In many cases they have been severely damaged by unchecked fires. Again, instead of improving the plantation by cutting out the dead, dying, and defective timber as material was needed, the better trees have usually been selected.

PRESENT STATUS OF FOREST PLANTING.

In general, the planted area in eastern Nebraska is decreasing, tho not uniformly so, for in some of the newer counties, particularly those in the northeastern part of the State, there is an increase. However, with the rapid rise in the price of land, together with an increased timber supply, due to planting by the early settlers, the activity in forest planting so characteristic of pioneer days has gradually declined, till in most parts of the State the planting done is more than offset by the cutting of the early plantations for fuel, posts, lumber, etc. Nurserymen say that the demand for forest tree seedlings declined very rapidly from about 1894. All agree, however, that there is a revival of interest in tree planting at the present time.

FOREST PLANTING OF THE FUTURE.

In past planting commercial considerations were largely ignored, but in the future these should be especially emphasized. The farmer should plant trees primarily with a view to raising wood crops, and to this end only the better and more profitable species should be used. It is easily possible to secure all the advantages of shelter and ornament and at the same time to derive a revenue from the forest plantation.

A SURVEY OF EXISTING PLANTATIONS.

The plantations here given are fairly well distributed over the region of this report. In but few cases were two groves of the same species measured in the same locality. The study was not confined to the best plantations only. Those groves of a given species which were typical of actual conditions at the present time were selected and measured. With cottonwood, for example, the study includes both fairly good and rather poor plantations, growing under widely different conditions of soil, moisture, and management.

The contents of any given plantation were determined by measuring a representative portion of it, called a sample plot, seldom less than one-tenth of the total area of the grove, often much more, and when the grove contained an acre or less, the entire area was measured. The sample plot in each case was selected to represent average conditions of the plantation. All trees on the sample plot were then calipered, and classified as dominant, intermediate, and overtopt. An average or sample tree for each class was then selected, felled, and analyzed. The stem was cut into 7-foot lengths down to 1 inch, and the branch wood into 4-foot lengths down to 2 inches in diameter. Frequently nearly all the trees would class as dominant, and the cutting of one sample tree would be sufficient to determine the total contents of the plot, disregarding the few trees that might fall in some other class. Care was taken in each case, however, to select enough trees to determine accurately the total volume of the plot.

The volume of each sample tree, including the stump, stem, and branch wood, was computed first in cubic feet.[a] Adding the volume of the group of trees on each sample plot, the total contents of the plot were obtained, and from this the total volume of the grove could be reckoned. In all cases the results were reduced to the unit of 1 acre. The volume in cubic feet was reduced to cords by using the factor 0.86 as the divisor.

TABLE 1.—*Comparative height of the principal species for planting in eastern Nebraska.*

Age.	Cotton-wood.	Silver maple.	Black walnut.	Green ash.	Hardy catalpa.	Honey locust.
Years.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
5	19	10	11	11	12	11
10	33	22	18	19	19	18
15	46	33	24	24	23	23
20	55	44	30	28	27	27
25	61	53	36	32	30	31
30	65	60	42	36	33	35
35	67	66	46	38	....	39
40	69	72	51	40	....	43
45	71	76	54	41	....	....
50	73	80	57	43	....	....
Number of trees measured	394	59	130	216	83	12

The table shows that all the species except silver maple make a better height growth during the first five years than for any other five-year period. Silver maple increases its rate of height growth over that of the first five years up to the twentieth year, and thereafter slowly declines. Cottonwood, green ash, and black walnut decline in height growth after the thirtieth year, the first two very rapidly. Black walnut maintains a very uniform growth up to that time. Hardy catalpa grows at a fairly uniform rate up to the twentieth year, and then gradually declines. Honey locust grows somewhat more slowly than hardy catalpa for the first ten years, but leads after that time, and its height growth up to the fortieth year is very uniform.

TABLE 2.—*Comparative diameter, breasthigh, of the principal species for planting in eastern Nebraska.*

Age.	Cotton-wood.	Silver maple.	Honey locust.	Black walnut.	Hardy catalpa.	Green ash.
Years.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
5	2.3	1.8	2.0	1.1	1.6	1.1
10	5.1	3.1	3.6	2.6	2.8	2.1
15	7.5	4.0	4.6	4.0	3.7	2.9
20	9.4	5.1	5.3	5.2	4.9	3.6
25	11.0	6.5	6.1	6.1	5.9	4.4
30	12.2	7.5	6.7	6.7	6.4	5.0
35	12.9	8.4	7.3	7.1	....	5.3
40	13.3	9.0	....	7.5	....	5.4
45	13.6	....	....	7.6	....	5.5
50	13.8	....	....	7.8	....	5.6
Number of trees measured	50	11	12	23	24	57

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[a] The stump was considered as a cylinder and the stem and branches as paraboloids. The volume of the sample tree being known, the total volume of the group or class it represented was obtained by the use of the following formula: $V=v\times\frac{S}{s}$, in which V=volume of the whole group or class; v=volume of the sample tree; S=basal area of group or class represented by the sample tree; s=basal area of the sample tree.

According to this table silver maple, honey locust, hardy catalpa, and green ash make their best diameter growth during the first five years. Cottonwood increases its rate of diameter growth from year to year up to the fifteenth, and black walnut up to the twentieth. The rate of diameter growth of the six species for the periods given is in the order named. Hardy catalpa declines rapidly in diameter growth after the twenty-fifth year, cottonwood and green ash after the thirtieth, and black walnut after the fortieth. Honey locust and silver maple both show a fairly uniform diameter growth to the end of the periods for which figures are given.

Heartwood composes the central portion of the stem, and may be distinguished from the sapwood by a difference in color. It is harder and more durable in contact with the ground than sapwood. The proportion of heartwood to sapwood increases with the age of the tree. Hence, when durability is required, old trees are more valuable than young ones.

The contents in fence posts were obtained by ocular estimates in the field. Experience proves this method to be accurate, especially where the trees run small in diameter, as in the great majority of the plantations measured. For example, in catalpa plantation No. 4 (p. 15) the survey gave $163 worth of first and second class posts, and the owner cut and sold $167 worth per acre from 4 acres a few months later. In all cases a post was reckoned as 7 feet in length. A second-class post varies from 3 to 3.9 inches and first-class from 4 to 5.9 inches in diameter at the small end. A log 6 to 7.9 inches in diameter at the small end was considered equal to two first-class posts, 8 to 9.9 inches as three first-class, and from 10 to 12 inches as four first-class posts. It will be seen that these dimensions are very liberal.

To calculate the volume in board feet of cottonwood and black walnut, the saw-log length of each tree was determined with a top diameter limit of 6 inches. The standard lengths of logs in Nebraska are 12, 14, and 16 feet, with a few 10 and 18 feet, the preferences being in the order named. With these standards as a guide, the trees were divided into saw logs, according to the demands of the trade. From taper measurements curves were drawn, and from these a model tree was constructed by which it was possible to know the diameter of any tree at any height and the diameter of any log at the small end outside the bark. From another set of curves the thickness of the bark of any tree at any height could be determined; therefore the diameter of any log inside the bark. The logs were then scaled by the Doyle rule.

As a guide in future planting, calculations were made on the cost of and returns from plantations of cottonwood, catalpa, green ash, honey locust, Osage orange, black walnut, and white willow. The figures in each case were based upon a typical example.

All items of expense were carried with 5 per cent compound interest from the year the plantation was established. Thus the costs given are a trifle higher than the actual, since some of the expenses, such as those for cultivating, except for the first year, and pruning, were not incurred at that time. However, it has not been possible to obtain data to show just when these expenses were incurred, so it is assumed that all were paid out the first year. The returns in each case are reduced to a net annual income with 5 per cent compound interest. In reckoning the returns for catalpa, Osage orange, black walnut, honey locust, and green ash, it is assumed that the stakes, or third-class posts, and fuel wood which can be obtained—products which are disregarded in the calculations—will pay the cost of harvesting the whole crop. Experience proves that they will do this.

TABLE 3.—*Amount of heartwood in trees of various diameters.*

Diameter breasthigh outside of bark.	Cottonwood.		Black walnut.		Hardy catalpa.	
	Diameter inside bark 8 feet high.	Diameter of heartwood 8 feet high.	Diameter inside bark 8 feet high.	Diameter of heartwood 8 feet high.	Diameter inside bark 7.5 feet high.	Diameter of heartwood 7.5 feet high.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1	0.7	....	0.5	0.2	0.8	0.7
2	1.5	0.6	1.4	.9	1.7	1.5
3	2.4	1.3	2.2	1.5	2.5	2.2
4	3.3	1.9	3.1	2.2	3.2	2.9
5	4.1	2.6	3.9	2.8	3.9	3.5
6	4.9	3.2	4.8	3.5	4.7	4.2
7	5.8	3.9	5.7	4.2	5.5	4.8
8	6.6	4.5	6.5	4.8	6.2	5.5
9	7.5	5.2	7.4	5.5	6.7	6.0
10	8.3	5.9	8.2	6.2	7.2	6.6
11	9.2	6.5	9.1	6.8	....	....
12	10.0	7.2	10.0	7.6	....	....
13	10.9	7.8	....	....	....	....
14	11.7	8.5	....	....	....	....
15	12.6	9.2	....	....	....	....
16	13.4	10.0	....	....	....	....
17	14.3	10.8	....	....	....	....
18	15.1	11.6	....	....	....	....
Number of trees measured	49		23		25	

Diameter breasthigh outside of bark.	Silver maple.		Green ash.		Honey locust.	
	Diameter inside bark 8 feet high.	Diameter of heartwood 8 feet high.	Diameter inside bark 7.5 feet high.	Diameter of heartwood 7.5 feet high.	Diameter inside bark 7.5 feet high.	Diameter of heartwood 7.5 feet high.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1	0.9	....	0.7	....	0.7	0.1
2	1.8	....	1.4	....	1.5	.7
3	2.8	....	2.2	0.1	2.4	1.4
4	3.7	0.5	3.0	.2	3.3	2.1
5	4.6	1.3	4.0	.6	4.3	2.9
6	5.4	2.1	5.1	1.3	5.3	3.8
7	6.2	2.9	6.4	2.4	6.3	4.7
8	7.0	3.7	....	....	....	....
9	7.8	4.5	....	....	....	....
10	8.5	5.4	....	....	....	....
11	....	....	....	....	....	....
12	....	....	....	....	....	....
13	....	....	....	....	....	....
14	....	....	....	....	....	....
15	....	....	....	....	....	....
16	....	....	....	....	....	....
17	....	....	....	....	....	....
18	....	....	....	....	....	....
Number of trees measured	11		58		12	

The preceding table shows that hardy catalpa has thruout a high percentage of heartwood. This is one of the many excellent qualities that make it so valuable as a post timber. Green ash develops no heartwood for some years, which accounts for the short life of posts from young trees. Honey locust begins to develop heartwood early, and the amount, tho small at first, increases rapidly with age. Black walnut, tho noted for its durability, does not develop enough heartwood to make a durable post until it is about 7 inches in diameter. Cottonwood has a smaller proportion of heartwood than black walnut, but even the heartwood of cottonwood decays quickly. Heartwood is not formed in silver maple for some years, and then it develops more slowly than in cottonwood.

COTTONWOOD.

Cottonwood deserves a prominent place in Nebraska tree planting. It grows very rapidly and can be propagated easily and cheaply, and the wood is coming into wide use. It is planted principally for fuel and lumber, but in the sand hills, and sometimes elsewhere, it is used extensively for fence posts. A cottonwood post lasts about three years, or five in exceptional cases. Posts are usually set out when green, with the bark on, which in part accounts for their short life.

The fuel value of cottonwood is relatively low, but owing to its rapid growth it is doubtful whether any other tree adapted to Nebraska conditions will produce as many heat units per acre in a given time. Under average conditions a plantation, on bottomland, will produce 3 cords per acre annually for the first twenty-five or thirty years. The majority of the bottomland groves reported run below this figure, but a large amount of cutting had been done in them before these measurements were taken, and none has been under the most favorable management.

Cottonwood grows best on rich, well-drained bottomlands. On uplands it will succeed in low situations, such as ravines and valleys, but on high, dry land is very apt to be killed by drought, and at best will yield considerably less than on bottomlands. The trees may do well for one, two, or several years, and then suddenly die. In the season of 1894, one of the driest in the history of the State, a very large proportion of cottonwood on the dry upland was either badly damaged or killed altogether.

The yield table for cottonwood is of interest as showing the relative value of saw-log and fuel-wood products. The table shows a total yield of 53,514 board feet of saw logs. These saw logs contain 260.1 cords of fuel wood. The common stumpage value of saw logs is $10 per thousand, and of fuel wood $2 per cord.

53,514 board feet, at $10 per thousand	$535.14
260.1 cords, at $2	520.20
Difference	14.94

In other words, unless saw logs command at least $10 per thousand on the stump, it is more profitable to sell the wood at $2 per cord.

Tho the average of saw-log yields is low, the growing of cottonwood lumber under proper management would pay good returns. It is coming more and more into use as a building material. From its tendency to warp, it can not be used where it is exposed to the weather, but for rough interior woodwork it is excellent. The lumber is also used locally for bridge planking, and gives excellent service. Elsewhere cottonwood is sold for the manufacture of paper pulp, boxes, furniture backs, and washboards.

TABLE 4.—*Yield of cottonwood.*

BOTTOM LAND.

No. of plantation.	County.	Area of grove.	Age of grove.	Dominant trees.		Yield per acre.					
				Average diameter breast-high.	Number trees per acre.	Saw-logs.	Fuel wood in addition.		Total.		Average annual.
		Acres.	*Years.*	*Inches.*		*Bd. ft.*	*Cu. ft.*	*Cords.*	*Cu. ft.*	*Cords.*	*Cords.*
1	Colfax	2.50	16	6.6	268	284	1,566	18.2	1,679	19.5	1.2
2	Madison	2.70	18	9.8	290	....	4,147	48.2	4,147	48.2	2.7
3	Platte	.48	18	8.5	413	....	4,109	47.8	4,109	47.8	2.7
4	Hamilton	.60	22	11.4	280	....	3,709	43.1	3,709	43.1	2.0
5	Dodge	2.40	22	10.8	201	1,612	2,842	33.0	3,561	41.4	1.9
6	Dixon	5.00	23	13.8	180	5,756	5,016	58.3	7,083	82.4	3.6
7	Pierce	40.00	25	12.1	185	3,007	3,544	41.2	4,809	55.9	2.2
8	Wayne	1.60	25	12.4	240	1,790	3,440	40.0	4,362	50.8	2.0
9	Jefferson	.70	25	11.2	338	2,362	2,139	24.9	3,193	37.1	1.5
10	Madison	2.80	26	11.7	250	3,597	6,747	78.5	8,171	95.0	3.7
11	Merrick	2.30	26	14.2	96	4,282	1,774	20.6	3,638	42.3	1.6
12	Stanton	2.00	29	12.0	220	3,154	4,820	56.0	6,152	71.5	2.5
13	Colfax	4.00	34	11.0	137	940	3,201	37.2	3,594	41.8	1.2
14	Lancaster	10.00	35	16.7	134	3,185	4,361	50.7	5,324	61.9	1.8
15	Hall	2.20	36	13.8	120	5,080	2,358	27.4	4,812	56.0	1.6
	UPLAND.										
16	Stanton	1.50	11	4.8	800	....	....	....	1,830	21.3	1.9
17	Pierce	2.20	13	6.7	410	....	....	....	1,976	23.0	1.8
18	Wayne	5.50	17	4.3	702	....	....	....	1,214	14.1	.8
19	Saunders	1.50	18	13.1	220	1,593	3,388	39.4	4,102	47.7	2.7
20	Cuming	4.50	18	6.9	308	....	....	....	2,047	23.8	1.3
21	Colfax	1.75	20	5.4	612	....	....	....	2,034	23.7	1.2
22	Lancaster	12.00	30	11.4	160	297	1,853	21.5	2,012	23.4	.8
23	Madison	50.00	31	13.8	129	4,019	3,740	43.5	5,310	61.7	2.0
24	Wayne	2.70	33	14.4	126	6,052	2,373	27.6	4,662	54.2	1.6
25	Cuming	2.50	33	11.6	181	2,167	3,272	38.0	4,368	50.8	1.5
26	...do	12.00	33	9.9	173	763	2,813	32.7	3,192	37.1	1.1
27	Otoe	20.00	34	12.7	179	1,389	2,511	29.2	3,133	36.4	1.1

Plantation No. 2.—This plantation is situated on land that is subject to overflow in wet seasons, and for this reason is especially adapted to the growing of trees. The altitude is approximately 1,500 feet. The soil is a rich, sandy loam and very deep.

The ground was put in a good state of cultivation just before it was planted, and the trees were set in furrows, 1-year-old seedlings being used. The spacing was 8 by 12 feet, thus requiring 454 trees per acre. A crop of corn was grown between the rows the first year, and the trees have never received any further cultivation. No data could be obtained on the returns from this crop, but it is safe to assume that it met the expense of the cultivation, which is therefore omitted in calculating the cost. The grove has never been pastured, and only the dead or dying trees have been cut out from time to time.

The trees are tall, straight, and thrifty. Owing to wide spacing, the stems are branchy. Of the present stand of trees 77 per cent will class as dominant and the remainder as intermediate. The ground is covered with a fairly dense stand of weeds and grass.

No data could be obtained on the cost of establishing this plantation, but the estimated cost is given below. The fuel wood would have a stumpage value of at least $2 per cord were it cut and sold. However, the wood is being consumed at home, thus saving the haulage, which would be at least 50 cents per cord. In reckoning the returns, therefore, a stumpage value of $2.50 per cord is assumed.

Preparation of ground	$2.50
Trees, 454, at $2.50 per M	1.14
Planting	2.00
Cultivation (cost paid by corn crop).	
Total	5.64
Interest on $5.64 for eighteen years, at 5 per cent, compounded	7.93
Total cost with 5 per cent compound interest at the end of eighteen years	13.57
48.2 cords, at $2.50 stumpage, farm value (value at end of eighteen years)	120.50

Deducting the cost, $13.57, from the value, $120.50, leaves $106.93 as the net value, which is equivalent to an annual net income at 5 per cent compound interest of $3.80 per acre.

This plantation affords an excellent example of what can be done by growing trees on land that is too wet for field crops. By planting it to trees, it furnishes a continuous supply of fuel, affords protection to the home, and yields a rental value above that of farm lands in the same locality during the same time. If the spacing had been closer and the plantation given good care, the returns would have been increased. The yield table for cottonwood shows that this plantation has given an annual yield of 2.7 cords per acre. Others made an equally good showing, and two furnish much higher yields.

HARDY CATALPA.

A considerable amount of hardy catalpa and its hybrids has been planted in southeastern Nebraska. The hardy kind succeeds well in this part of the State, but most of the hybrid forms have failed, and on this account catalpa is in ill repute with many people. A study of the table, however, will prove that hardy catalpa will not only succeed, but under right conditions will yield paying returns. Plantation 4 is now being harvested. Six acres were cut clear the past two winters, and the fence posts have yielded a gross return of $207 per acre. The owner values the additional fuel wood at $5 per acre. The cost of harvesting the crop was $25 per acre. The first-class posts sell for 14 cents, the second-class for 9 cents, the third-class, or stakes, for 4 cents. The value of the fence posts in No. 12 is $332 per acre, and material worth $52 per acre has been sold from this plantation in the past two years, making its gross value $383 per acre, to say nothing of the large number of posts that were previously cut from it.

All the plantations herein reported are in the region south of the Platte River and east of Hastings. As a rule, the species has not done well west of York. It was not found in plantation form north of the Platte River, tho many single trees in good condition were noted. Successful plantations may be seen at Yankton and Viborg, S. Dak. Hardy catalpa can probably be grown on good soils thruout the region covered by this report, except in the sand hills. Wherever it will succeed, no other tree will pay so well. It requires a deep, fertile, porous soil, and the situation is still more desirable if the water table is within 10 or 15 feet of the surface. These conditions exist in many of the river bottoms, especially in the Platte River Valley.

TABLE 5.—*Yield of hardy catalpa.*

No. of plantation.	County.	Area of grove.	Age of grove.	Dominant trees.		Yield per acre.								
				Average diameter breast-high.	Number of trees per acre.	Total.		Posts.			Average annual posts.			Fuel wood.
								1st.	2d.	Total.	1st.	2d.	Total.	
		Acres.	*Yrs.*	*In.*		*Cu. ft.*	*Cords.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*Cords.*
1	Pawnee	13	14	4.3	1,583	2,378	27.7	647	1,363	2,010	46.2	97.3	143.5	2
2	.....do......	8	15	3.1	2,571	1,687	19.1	18	510	528	1.2	34	35.2	1.3
3	Richardson	.75	17	2.9	2,624	2,196	25.5	220	156	376	12.9	9.2	22.1	1.5
4	Butler	14.50	19	3.7	1,747	1,759	20.5	460	1,096	1,556	24.2	57.7	81.9	1.1
5	Lancaster..	.75	20	3.3	800	1,010	11.7	......	256	256	......	12.8	12.8	.6
6	Adams.....	.32	20	3.3	1,737	1,229	14.3	34	179	213	1.7	9	10.7	.7
7	Richardson	.50	20	6	376	1,237	14.4	721	300	1,021	36.1	15	51.1	.7
8	York........	2.50	21	4.7	406	651	7.6	242	140	382	11.5	6.7	18.2	.4
9	.....do......	1.70	23	5	241	651	7.6	326	150	476	14.2	6.5	20.7	.3
10	.....do......	2	24	5.5	592	1,421	16.5	702	532	1,234	29.3	22.2	51.4	.7
11	Lancaster..	.52	25	6.7	660	1,655	19.2	931	542	1,473	37.2	21.7	58.9	.8
12	Nemaha ...	2.40	25	6.6	747	4,129	48	1,829	845	2,674	73.2	33.8	107	1.9

Plantations Nos. 1 and 2.—These plantations occupy adjacent grounds, belong to the same person, and have been given exactly the same care. They are treated together, therefore, in order to compare the returns. They are situated on upland prairie. The altitude is approximately 1,200 feet. The soil is a sandy loam with a small admixture of gravel. The subsoil is of clay. The land occupied by No. 1 was in virgin prairie sod till the spring of 1899, when it was broken out and allowed to stand idle till the following year. No. 2 is on land that was old and worn out when the trees were planted.

Plantation No. 1 was established in 1890, No. 2 in 1889, their respective ages when measured being 14 and 15 years. In both cases the ground was put in a thoro state of cultivation immediately before the trees were planted. One-year-old stock was used, spaced 4 by 4 feet. The plantations were cultivated like corn the first two years, since when no further care has been given them, except that a few acres were pruned several years ago.

The general health and appearance of the trees are good, and the plantations on the whole are thrifty. There is some decay noticeable, caused by fungus entering where the dead limbs have persisted. The plantations have always been protected against fire and live stock, and every opportunity has been afforded, therefore, for the building up of forest conditions. The crown cover, save for an opening here and there, is quite complete, and demonstrates that catalpa can be depended upon to form a canopy sufficiently dense to shut out weeds and grass.

The owner has kept a strict account of all expenses incurred in establishing and maintaining these plantations, and the figures given on the cost are taken from his records. The cost is assumed to be the same for both plantations.

Plantation No. 1.

COST (ACTUAL).		RETURNS.	
Plants, 2,722, at $1.15 per M	$3.13	First-class posts, 647, at 14 cents	$90.58
Preparation of the ground, cultivation, and pruning	18.46	Second-class posts, 1,363, at 9 cents	122.67
Total	21.59		
Interest on $21.59 for fourteen years, at 5 per cent, compounded	21.16		
Total cost at the end of fourteen years	42.75	Value at the end of fourteen years	213.25

Deducting the cost, $42.75, from the value, $213.25, leaves $170.50 as the net income at the end of fourteen years, which is equivalent to an annual net income at 5 per cent compound interest of $8.69 per acre.

Plantation No. 2.

COST (ACTUAL).		RETURNS.	
Plants, 2,722, at $1.15 per M	$3.13	First-class posts, 18, at 14 cents	$2.52
Preparation of the ground, cultivation, and pruning	18.46	Second-class posts, 510, at 9 cents	45.90
Total	21.59		
Interest on $21.59 for fifteen years at 5 per cent compound interest	23.29		
Total cost at the end of fifteen years	44.88	Value at the end of fifteen years	48.42

Deducting the cost, $44.88, from the gross returns, $58.42, leaves $3.54 as the net income at the end of fifteen years, which is equivalent to an annual net income at 5 per cent compound interest of 16 cents per year.

This plantation would make a much better showing if measured in three or four years. Because of the impoverished condition of the soil, the trees are only just reaching post size. Most of them are sound and thrifty and will make fence posts in a few years.

These two plantations make it clear that catalpa requires a good soil for its best development, and emphasize the fact that with trees as with other crops the highest returns are realized from the best soils.

GREEN ASH.

Next to cottonwood, green ash has been the most widely planted tree in eastern Nebraska. Its range for planting comprizes the entire region, except portions of the sand hills. It succeeds best on low land, yet no other tree, except possibly honey locust, is so well adapted to dry upland planting. In the sand hills it can not be planted on the upland, but does tolerably well in the valleys.

In general, the timber of green ash is only slightly inferior to that of white ash, and the tree is much hardier. It should be planted mainly for posts and fuel. Its fuel value is relatively high, and under favorable conditions a yield of at least 1 cord per year per acre may be realized. As a post timber green ash is not among the best, but is widely used. When cut in the fall or winter and thoroly seasoned the posts are fully twice as serviceable as when set green. Its diameter growth is somewhat lower than that of catalpa. In good soil it will attain post size in from twelve to fifteen years, but since its heartwood does not develop early, posts cut from young trees are not very durable.

TABLE 6.—*Yield of green ash.*

No. of plantation.	County.	Area of grove.	Age of grove.	Dominant trees.		Yield per acre.								
				Average diameter breast-high.	Number of trees per acre.	Total.		Posts.			Average annual.			
								1st.	2d.	Total.	Posts.			Fuel wood.
											1st.	2d.	Total.	
		Acres.	*Yrs.*	*In.*		*Cu. ft.*	*Crds.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*Cords.*
1	Jefferson...	1.30	17	3.1	540	275	3.2	......	35	35	......	2.1	2.1	0.2
a2	Washington	2.50	17	4.7	1,083	1,326	15.4	310	430	740	18.2	25.3	43.5	.9
3	Nemaha ...	1.00	18	3.7	1,054	1,582	18.4	442	494	936	24.6	27.4	52.0	1.0
4	Polk	.92	19	4.2	965	840	9.8	130	365	495	6.8	19.2	26.0	.5
5	Colfax	1.50	19	2.9	844	523	6.1	28	172	200	1.5	9.1	10.5	.3
6	Hall	2.50	20	2.4	1,304	722	8.4	20	28	48	1.0	1.4	2.4	.4
7	Clay	3.43	20	4.2	1,446	963	11.2	30	232	262	1.5	11.6	13.1	.6
8	Otoe	3.00	21	4.5	744	1,014	11.8	290	464	754	13.8	22.1	35.9	.6
9	Hamilton ..	2.50	21	4.2	932	1,011	11.8	167	312	488	8.4	14.9	23.2	.6
10	York........	7.00	21	4.2	714	1,004	11.7	288	502	790	13.7	23.9	37.6	.6
11	Fillmore ...	.99	21	3.7	928	973	11.3	218	294	512	10.4	14.0	24.4	.5
12	Polk	1.20	21	4.9	725	1,263	14.7	300	317	617	14.3	15.1	29.4	.7
13	Kearney ...	1.04	21	6.2	805	1,611	18.7	702	504	1,206	33.4	24.0	57.4	.9
14	Richardson	.80	21	4.3	1,192	2,063	24.0	1,072	584	1,656	51.1	27.8	78.8	1.1
15	Johnson ...	.95	22	5.1	492	640	7.4	228	312	540	10.4	14.2	24.5	.3
16	Saunders...	1.56	22	4.8	446	648	7.5	138	188	326	6.3	8.5	14.8	.3
17	Hamilton ..	1.10	23	5.3	496	1,339	15.6	294	280	574	12.8	12.2	25.0	.7
18	York........	1.70	23	4.7	835	1,492	17.3	425	410	835	18.5	17.8	36.3	.8
19	Webster....	6.60	25	3.8	517	343	4.0	51	155	206	2.1	6.2	8.3	.2
20	Fillmore ...	4.24	25	5.7	345	1,067	12.4	190	111	301	7.6	4.4	12.0	.5
21	Lancaster ..	.48	25	5.3	497	1,269	14.8	327	240	567	13.1	9.6	22.7	.6
22	Polk	3.10	27	6.2	309	1,001	11.6	441	208	649	16.3	7.7	24.0	.4
a23	Butler	.38	29	4.9	950	1,735	20.1	490	480	970	16.9	16.6	33.4	.7
24	Clay	5.30	30	5.8	352	860	10.0	246	184	430	8.2	6.1	14.3	.3
25	Saunders ..	1.50	30	6.1	368	1,662	19.3	1,068	370	1,438	35.6	12.3	47.9	.6
26	.....do......	1.10	30	7.4	236	2,273	26.4	1,162	486	1,648	38.7	16.2	54.9	.9
27	.....do......	1.50	32	4.6	553	1,106	12.9	343	330	673	10.7	10.3	21.0	.4
28	Cuming	.25	33	4.6	530	1,272	14.8	465	420	885	14.1	12.7	26.8	.5
29	Saunders...	3.10	33	7.0	383	1,623	18.9	1,040	420	1,640	31.5	12.7	44.2	.6

a Bottomland.

Plantation No. 13.—This plantation is situated on rolling upland, tho it is cut by a small draw. The soil is a deep, fertile, sandy loam. In the draw it is covered by humus to a depth of several feet. On the tops of the knolls it is lighter in color, and humus is lacking.

The trees were planted in 1883, one-year-old seedlings about 8 inches high being used. These were small and inferior in quality. Before planting, the ground was plowed and subsoiled to a depth of 18 inches, and afterwards thoroly harrowed. The spacing was 6 by 8 feet, requiring 908 trees per acre. Cultivation was given for the first seven years. The trees were pruned six or seven years ago to a height of 8 feet. The grove has always been protected from live stock.

Forty dollars worth of posts, poles, and fuel per acre have been cut from the plantation.

The trees are tall and straight, with bushy crowns. The old wounds caused by pruning are completely healed over. All the trees will furnish posts, some as many as six.

The success of this plantation is remarkable, since it is located within a few miles of the ninety-ninth meridian, where the conditions are semiarid. It is probable that this success is due to the deep plowing given the ground before it was planted, and the subsequent cultivation given the plantation until the trees were large enough to take possession of the soil.

The cost of establishing and maintaining this plantation is given in the owner's record. The prices assigned the posts are considerably lower than those which the owner says he can obtain.

COST (ACTUAL).		RETURNS.	
Preparation of the ground	$3.50	First-class posts, 702, at 10 cents	$70.20
Plants, 908, at $2 per M	1.81	Second-class posts, 504, at 7½ cents	37.80
Planting	.75	Posts, poles, and fuel cut in the past	40.00
Cultivation, seven years	5.00		
Pruning	2.00		
Fencing	1.00		
Total	14.06		
Interest on $14.06 for twenty-one years, at 5 per cent, compound interest	25.11		
Total cost at the end of twenty-one years	39.17	Value at the end of twenty-one years	148.00

Deducting the cost, $39.17 from the value, $148, leaves $108.83 as the net income at the end of twenty-one years, which is equivalent to a net annual income, at 5 per cent compound interest, of $3.05 per acre. Anyone who knows the conditions that have prevailed in this part of the State and the reverses that farming has suffered for the period included in the life of the plantation knows that this would be a splendid showing for any sort of crop. Adding to the returns the value of the plantation as a windbreak to the farmstead, it has yielded the owner handsome profit on his investment, besides enhancing the value of the farm of which it forms a part. With the same careful management green ash would give better returns farther east in the State. Several other plantations included in the yield table for this species show a yield in fence posts per year not far behind this one, and for No. 14 the returns are considerably better.

In view of the showing made by green ash, particularly in the more unfavorable western counties, it is obvious that it should have a prominent place in future planting.

BLACK WALNUT.

Black walnut requires a rich soil for its best development. It is especially adapted to the river valleys, where the soil is fertile, moist, and well drained. It will succeed fairly well on the upland in the eastern counties, but it should be planted commercially only on the bottomlands. Its growth in diameter is nearly equal to that of catalpa, and under favorable conditions it will reach post size in from ten to twelve years. Young timber, however, because of its large percentage of sapwood, does not make a first-class fence post, and the rotation should in consequence be not less than twenty-five years.

Walnut makes good fuel, but its timber is too valuable to be used for this purpose. The greatest returns will be realized from this species when it is planted for lumber. The time required for the production of saw logs, however, is from seventy to eighty years, which is a longer rotation than the average planter could afford adopt.

Black walnut can not be depended upon to form a complete crown cover. It is very intolerant under Nebraska conditions, and shades itself out before it has formed a canopy anything like dense enough to shut out weeds and grass. The species therefore should be planted in mixture with some more heavily foliaged tree. For bottom soils a mixture of walnut and hardy catalpa, in the proportion of 1 to 3, according to the following diagram, is suggested:

(4 feet by 4 feet.)

W C W C

C C C C

W C W C

C C C C

W=black walnut; C=hardy catalpa.

Number of trees required per acre.

Black walnut	680
Hardy catalpa	2,040
Total	2,720

The walnut should be planted two years in advance of the catalpa, since, if the two are planted at the same time, there is danger that the walnut will be overtopt. A field crop, such as potatoes, could be grown with the walnut for the first two years. The catalpa should be planted in the spring of the third year. After eight or ten years it may gradually be thinned out, and by the time the plantation is 25 years old three-fourths of the catalpa and all defective walnut trees should have been removed. This will leave most of the walnut trees, but only the best specimens of the catalpa, and at this time the stand will probably not exceed 700 to 800 trees per acre of both species. By the fortieth year the remaining catalpa should have been harvested, as well as all defective specimens of the walnut, leaving a probable stand of 400 trees, which by this time will have attained sufficient size to take care of themselves. It is likely that in the openings a certain percentage of the catalpa stumps will sprout, and this sprout growth will still further assist the walnut.

TABLE 7.—*Yield of black walnut.*

BOTTOMLAND.

No. of plantation.	County.	Area of grove.	Age of grove.	Dominant trees.		Yield per acre.									
				Average diameter, breasthigh.	Number of trees per acre.	Total.		Saw logs.	Posts.			Average annual posts.			Fuel wood.
									1st.	2d.	Total.	1st.	2d.	Total.	
		Acres.	*Yrs.*	*In.*		*Cu.ft.*	*Cords.*	*Bd.ft.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*Cords.*
1	Dixon	5.00	15	6.6	228	817	9.5	......	394	154	548	26.3	10.3	36.5	0.6
2	Washington	2.17	30	6.7	690	2,319	27.0	......	......	....	....	.....	.....	....	.9
3	Burt.........	4.70	32	9.0	244	2,558	29.7	320	1,192	284	1,476	37.3	8.9	46.1	.9
4	Johnson	.50	32	8.2	328	2,382	27.7	......	1,240	368	1,608	38.8	11.5	50.3	.9
5	Douglas	.74	33	12.1	97	2,628	30.5	1,500	......	....	....	.....	.....	....	.9
6	Otoe........	.50	34	7.9	300	1,564	18.2	......	1,596	666	2,262	46.9	19.6	66.5	.5
7	Burt.........	12.50	34	8.4	310	3,045	35.4	......	1,862	316	2,178	54.8	9.3	64.1	1.1

UPLAND.

No. of plantation.	County.	Area of grove.	Age of grove.	Average diameter, breasthigh.	Number of trees per acre.	Total (Cu.ft.)	Total (Cords)	Saw logs.	Posts 1st.	Posts 2d.	Posts Total.	Average annual posts 1st.	Average annual posts 2d.	Average annual posts Total.	Fuel wood.
8	Richardson.	0.70	18	4.3	901	1,803	21.0	......	734	535	1,269	40.8	29.7	70.5	1.2
9	Stanton.....	.50	19	5.2	532	1,117	13.0	......	488	358	846	25.7	18.8	44.5	.7
10	Cass	1.40	23	5.7	510	1,140	13.3	......	740	494	1,234	32.2	21.5	53.7	.6
11	Johnson	1.50	30	7.2	264	1,060	12.3	......	806	72	878	26.9	2.4	29.3	.4
12	Saunders ...	......	31	6.7	266	1,631	19.0	......	950	218	1,168	30.7	7.0	37.8	.7
13	Cass	8.00	42	11.2	200	3,688	42.9	1,720	1,637	282	1,919	39.0	6.7	45.7	1.0

Plantation No. 7.—This plantation is situated on the Missouri River bottom. The soil is a rich black loam, 5 to 6 feet deep. It is fresh, porous, and exceedingly fertile. The site is traversed by a small stream, which occasionally overflows and courses out thru the grove, inundating a good part of it. Water does not stand on the surface more than a day or so.

The plantation was grown direct from the seed. Cultivation had been given the land for two years previous to planting. The nuts were planted in the fall of 1869. After the ground had been plowed and harrowed as for corn, single rows, 4 feet apart, were marked off with a common marker. Furrows were then run 8 feet apart at right angles to the marks. The nuts were dropt at the intersection of the furrows with the marks, thus giving a spacing of 4 feet by 8 feet. One nut was planted at a place, making 1,360 nuts per acre. It required 25 bushels ("shucks" on) to plant the 12½ acres. They were purchased from the Indians at 25 cents per bushel. After the nuts were dropt, they were covered by filling the furrows with a harrow. This covered them rather too deep, so that only about two-thirds of the number came up the first year.

In the spring of 1870 corn was planted in every other row, thus giving nearly a half stand. Both the corn and the trees were thoroly cultivated and a good half crop of corn was raised that year. In the spring of 1871 the land was sowed to oats and an excellent crop was raised. The oats were harvested with a sithe. The ground was left in the stubble and the plantation has received no further cultivation.

In the spring of 1872, and again in 1875, the trees were pruned, at a total cost of $2 per acre. No further expense has ever been incurred in the care of the plantation. The practise has been to cut the supprest or otherwise inferior trees. These have furnished about 1,000 fence posts, or 80 posts per acre, and the additional firewood has paid for the cost of harvesting the posts. The plantation has been moderately pastured to hogs since the third year of its life.

There is only a trace of humus. The litter consists of leaves and twigs and is from one-fourth to one-half an inch deep. Bluegrass and weeds cover the entire surface, though the sod is nowhere dense. An occasional clump of elderberry and a few gooseberry bushes constitute the only underbrush.

The trees were pruned early and there is a large percentage of clear, straight boles. A few would make small saw logs. They have made an excellent height growth and are in a healthy, thrifty condition. The practise of making gradual thinnings to favor the best trees leaves the present stand comparatively free from disease or defects of any kind.

The statement of the cost of this plantation is taken from the owner's record. The two field crops raised in the plantation paid for its entire cost, which is, therefore, not considered in calculating the final returns.

COST (ACTUAL).		RETURNS.	
Plowing the ground	$0.75	First-class posts, 1,862, at 12½ cents	$232.75
Harrowing and marking	.25	Second-class posts, 316, at 8 cents	25.28
Nuts, 2 bushels, at 25 cents	.50	Posts sold in the past	80.00
Planting	.40		
Pruning	2.00		
Total	3.90	Value at the end of thirty-four years	338.03

Three hundred and thirty-eight dollars and three cents as the net income at the end of thirty-four years is equivalent to an annual net income at 5 per cent compound interest of $3.97. It is estimated that the rental value of the land as a hog pasture has been at least $1 per acre, which added to $3.97 gives nearly $5 as the total annual net income per acre above 5 per cent compound interest.

HONEY LOCUST.

Honey locust is an exceedingly valuable tree for planting in Nebraska. It is hardy, enduring extremes of both heat and cold, is drought resistant, and fairly free from insect attacks and fungous diseases. Like green ash, it thrives best on well-drained bottomland soils, but it is unusually well adapted for upland planting in the dry sections. It should be widely planted in the western counties.

The economic uses of the timber of honey locust are chiefly for fuel and fence posts. It will produce about 1 cord of fuel yearly per acre. Its rate of growth in diameter is somewhat more rapid than that of green ash, and it reaches post size earlier. Yield Table 8 shows that one plantation near Grand Island has produced 2,141 posts in twenty-nine years, or 73 posts per year; while another near Verdon, in Richardson County, gave a yield in thirty-five years of 2,644 posts, or an average of 76 posts per year. The timber to be durable in contact with the ground must be well seasoned.

Table 8.—*Yield of honey locust and Osage orange.*

HONEY LOCUST.

No. of plantation.	County.	Area of grove.	Age of grove.	Dominant trees.		Yield per acre.								
				Average diameter breasthigh.	Number of trees per acre.	Total.		Posts.			Average annual posts.			Fuel wood.
								1st.	2d.	Total.	1st.	2d.	Total.	
		Acres.	*Yrs.*	*In.*		*Cu. ft.*	*Cords.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*Cords.*
1	Adams	0.72	18	3.6	600	506	5.9	110	197	307	6.1	10.9	17.1	0.3
2	.....do......	1.70	23	4.2	1,052	1,109	12.9	102	280	382	4.4	12.2	16.6	.6
3	Johnson ...	.20	28	3.7	895	1,343	15.6	420	405	825	15.0	14.5	29.5	.6
4	Hall	.82	29	6.0	1,028	2,941	34.1	1,314	827	2,141	45.3	28.5	73.8	1.2
5	Richardson	2.25	35	6.5	474	4,094	47.6	2,196	448	2,644	62.7	12.8	75.5	1.4
	OSAGE ORANGE.													
1	Nemaha ...	1.17	32	6.3	453	2,046	23.8	760	522	1,283	23.8	16.3	40.1	0.7

Plantation No. 4.—This plantation is situated in the Platte River Valley, and its relative altitude is only a few feet above the river. The absolute altitude is about 1,860 feet.

The soil is a sandy loam, dark gray to blackish in color. It is deep, fresh, mellow, porous, and exceedingly fertile. The subsoil is a light-colored, porous, loamy sand, intermixt with small gravel.

Only very meager data could be obtained on the history of this plantation. The original stand was 1,418 trees per acre, making the spacing a little less than 4 by 8 feet. The present stand is 1,028 trees per acre. The loss is mainly due to natural thinning, since little cutting has been done. About 40 per cent of the present stand has become suppressed, and many of these trees are dying. There should be an improvement cutting made, which would remove the deteriorating trees. The grove has been used as a hog pasture for many years.

COST (ESTIMATED).	
Preparation of the ground	$2. 50
Plants, 1,400, at $3 per thousand	4. 20
Planting	3. 00
Cultivation, three years	5. 00
Total	14. 70
Interest on $14. 70 for twenty-nine years, at 5 per cent compounded	45. 80
Total cost at end of twenty-nine years	60. 50

RETURNS.	
First-class posts, 1,314, at 10 cents	$131 40
Second-class posts, 827, at 7½ cents	62. 03
Value at end of twenty-nine years	193. 43

Deducting the cost, $60.50, from the gross returns, $193.43, leav $132.93 as the net income at the end of twenty-nine years, which equivalent to an annual net income with 5 per cent compound interest of $2.13 per acre, disregarding the thinnings. To this there shou be added the rental value of the land for pasture, since it has been used for this purpose. Furthermore, the plantation forms part of an extensive shelterbelt, which completely surrounds the farm buildin and thus assumes a value as a protection, tho it is impossible to express this in dollars and cents.

OSAGE ORANGE.

When the State was first settled, Osage orange was planted extensively for hedge fences, especially in the southeastern counties, tho but few such fences have been planted in recent years. This species has never been widely planted in groves. Only two or three plantations were noted in the course of the study. Osage orange is one of the valuable trees for forest planting, and should be more extensively used for this purpose. It is hardy south of the Platte River, but should be planted sparingly north of it, since it is likely to winterkill.

To succeed commercially, Osage orange requires a moderately rich soil. It is fairly drought resistant, but unless moisture conditions are favorable its growth is slow. Planting will be most profitable in the river valleys, where the soil is fertile and moist. On uplands, especially in poor soils, it fails. A notable example of such failure is a 17-acre plantation in Pawnee County established in 1889. The site is typical prairie upland, and the soil was old and worn when planted.

The trees have done very poorly. They are short, often not over 5 feet high, and very branchy, and will never be of much value. It is true that no tree could have made its best growth on this site, but if the ground had been planted to hardy catalpa the results would have been much better, as is evidenced by the fact that where catalpa and Osage orange are planted side by side on this tract the former is from 6 to 10 feet the taller, and is a much superior tree in every way.

With the introduction of barb-wire fences, Osage orange as a fence material has gone out of favor, and its use for this purpose in Nebraska is probably a thing of the past. As a post timber, however, it is unexcelled, and it is chiefly for this that it is recommended for commercial planting. Under favorable conditions it will reach post size in from twelve to fifteen years. Because of the well-known durability of Osage orange in contact with the ground and its great strength, it always commands good prices. The fuel value of the tree is very high, and the cordwood from a plantation gives it an added value. For farm repairs, too, such as whiffletrees, plow beams, etc., it is exceedingly valuable.

The windbreak value of Osage orange must not be overlookt. Its low-branching habit and ability to grow in close stands make it one of the most valuable of the broadleaf trees for this purpose.

Plantation No. 1.—This plantation is situated on a prairie upland farm. The site is low and slopes gently to a ravine along the west side. The soil is a rich black loam, fresh, well drained, and deep. The subsoil is a clay, underlaid with limestone at a depth of from 10 to 12 feet.

The ground was used at first as a seed bed for growing Osage orange plants for the market when this species was being planted so extensively as a hedge fence. When hedge fences went out of favor the demand for plants ceased and the seed bed was abandoned. The last crop of plants was sold in the spring of 1871, and the present stand has sprung up from the culls that were left at that time. The young plants were twice turned over in an effort to destroy them, but each time they came up from the roots again. The plan was then tried of grubbing them out, but even this heroic treatment was a failure. It was then decided to allow the plantation to stand. It has never had care of any sort. On the contrary, it has been very severely pastured by all kinds of live stock. Despite these adverse conditions it is a valuable plantation, as its products will show.

The owner has sold 100 telegraph poles per acre from the plantation in the past two years. The poles ran from 16 to 20 feet in height, and would average 18 feet. It is estimated that 700 first-class and 500 second-class posts per acre have been cut from these groves in the past. This estimate is believed to be conservative, since the owner states that the plantation has furnished a considerable part of the posts required in keeping his 450-acre farm fenced for twenty years. He has also cut more or less material, such as wagon reaches, tongues, whiffletrees, and windmill posts. This material, together with the additional fuel wood, it is estimated would meet the cost of cutting the posts.

The heavy pasturing of the plantation for many years has prevented the development of forest conditions. There is only a trace of humus, and a very small amount of litter. Ground cover and underbrush are almost completely shut out by the live stock and shade. Reproduction is prevented for the same reasons.

With but few exceptions the trees are sound. A few have been scarred by the rubbing of stock, and there is some decay where limbs have been broken off. The trees tend to be branchy and rather crooked.

Since the plantation sprang up voluntarily and has never received cultivation or other care, there was no expense in establishing and maintaining it. However, the estimated cost of establishing such a plantation at the present time is taken into account in calculating the net income, in order that the computation of returns may be of greater practical benefit to prospective planters.

COST (ESTIMATED).	
Preparation of the ground	$2.50
Plants, 2,722, at $2 per thousand	5.44
Planting	6.00
Cultivation, three years	5.00
Total	18.94
Interest on $18.94 for thirty-two years at 5 per cent compounded	71.31
Total cost at end of thirty-two years	90.25

RETURNS.	
First-class posts, 760, at 15 cents	$114.00
Second-class posts, 522, at 10 cents	52.20
Poles cut in the past, 100, at 60 cents	60.00
First-class posts cut in the past, 700, at 15 cents	105.00
Second-class posts cut in the past, 500, at 10 cents	50.00
Net income at the end of thirty-two years	381.20

Deducting the cost, $90.25, from the present value, $381.20, leaves $290.95 as the net value, which is equivalent to an annual net income with 5 per cent compound interest of $5.06 per acre. This may be regarded as net profit, since the plantation has always been used to its full capacity as a part of the farm stock yards. It has afforded also ideal shade and shelter for stock for many years, tho the abuse from this cause has reduced materially the returns from the project. Had this plantation always been under good management it would have made a still better showing in the value of the returns.

Table 9.—*Yields of other species.*

WHITE WILLOW.

Number of plantation.	County.	Area of grove.	Age of grove.	Dominant trees.		Yield per acre.		
				Average diameter breast-high.	Number trees per acre.	Total.		Average annual.
		Acres.	*Years.*	*Inches.*		*Cu. feet.*	*Cords.*	*Cords.*
1	Washington	1.20	16	5.5	826	3,967	46.1	2.9
2	Dodge	1.60	22	8.2	384	4,339	50.5	2.3
	SILVER MAPLE.							
1	Otoe	1.00	14	4.6	340	949	11.0	0.8
2	Jefferson	2.70	16	2.9	1,668	1,879	21.8	1.4
3	Richardson	.66	18	4.2	1,418	3,120	36.3	2.0
4	Dodge	7.50	25	6.9	437	3,321	38.6	1.5
5	Cass	1.50	27	7.0	403	2,546	29.6	1.1
6	Saunders	2.00	30	8.6	238	2,246	26.1	.9
7	Cass	.81	32	8.4	518	3,628	42.2	1.3
8	Saunders	2.10	33	7.9	303	2,639	30.7	.9
9	Dodge	10.00	34	9.9	221	2,055	49.6	1.5
	BOXELDER.							
1	Lancaster	2.50	18	2.9	798	500	5.8	0.3
2	.....do	1.00	24	6.8	333	1,519	17.7	.7
3	Platte	.30	24	5.9	666	3,218	37.4	1.6
4	York	1.50	25	8.7	302	3,443	40.0	1.6
	WHITE PINE.							
1	Otoe	1.80	12	4.6	916	1,489	17.3	1.4

WHITE WILLOW.

In mentioning the trees suitable for planting in eastern Nebraska white willow must not be omitted. It is hardy thruout this region. It has been widely planted as a wind-break, for which purpose its quick growth, profuse branching habit, and hardiness especially commend it. Its fuel value is somewhat greater than that of cottonwood-tho in plantations it does not grow quite so rapidly. Like the cottonwood, it is a moisture-loving tree, and on this account does not do well on dry upland. It is especially adapted for planting on low, marshy ground bordering the streams and ravines. White willow has been used to some extent for fence posts, and for this it is somewhat more durable than cottonwood. Its tendency to produce a crooked stem makes it difficult to grow a large percentage of straight trees per acre.

Plantation No. 2.—This plantation is situated on the first bottom of the Platte River. The altitude is about 1,200 feet. The soil is a rich sandy loam. The plantation was established by planting 1-year-old seedlings in rows 8 feet apart, and 2 feet apart in the row, thus requiring 2.722 trees per acre. It evidently has had very little care of any sort, and always has been used as a hog pasture. Heavy thinnings have furnished fuel for years.

Since the fuel value of white willow is about 15 per cent higher than that of cottonwood, it is worth at least 25 cents more per cord. The fuel wood from this plantation is being consumed at home, and hence is given a farm value.

COST (ESTIMATED).		RETURNS.	
Preparation of ground	$2.50	50.5 cords, at $2.75 stumpage (farm value)	$138.88
Trees, 2,722, at $2.50 per thousand	6.81	Cut in the past, 15 cords, at $2.75	41.25
Planting	6.00		
Cultivation two years	3.00		
Total	18.31		
Interest on $18.31 for twenty-two years at 5 per cent compounded	35.25		
Total cost at the end of twenty-two years	53.56	Value at end of twenty-two years	180.13

Deducting the cost, $53.56, from the present value, $180.13, leaves $126.57 as the net value, which is equivalent to an annual net income of $3.29 per acre, not to mention the rental value of the land as a hog pasture. It will be noted that the annual yield of Plantation No. 1 is higher than that of No. 2.

SILVER MAPLE.

Silver maple ranks fourth in abundance among the planted trees in eastern Nebraska. It is hardy thruout the region, tho it attains its best development on the lowlands. It is, in fact, not well adapted for upland planting, but it succeeds there somewhat better than either cottonwood or willow.

Silver maple should be planted mainly for shelter and firewood. There are better trees, however, for both purposes. Its fuel value is considerably higher than that of cottonwood or willow, but its yield is much less than either.

BOXELDER.

Among the planted trees, boxelder ranks third in abundance, yet its place in economic planting is more limited than that of silver maple. Usually, wherever it will succeed, some more valuable tree could be grown. It has been used for fence posts, and farmers and ranchmen say it is somewhat more durable in contact with the soil than either cottonwood or willow. However, on account of its branchy habit and tendency to crookedness, only a small percentage of the trees can be expected to make posts. Its fuel value is somewhat higher than that of cottonwood and not as high as that of willow, but its yield per acre in a given time is considerably less than either. Perhaps the chief economic value of this species is for use as a nurse for some of the better trees, such as walnut, or for shelter and shade. Its rapid growth and branchy form are in its favor for windbreak planting, and as a shade tree it has commendable qualities. It is very hardy and easily propagated.

RUSSIAN MULBERRY.

Russian mulberry has a limited value in forest planting, especially on the dry uplands in the southwestern counties. It can not be planted with safety far north of the Platte River. On account of its low-branching habit it is one of the best of trees for windbreaks, either in belts or in single rows. Many orchardists prefer it, for the birds feed upon its fruit instead of the fruit of the orchard.

As a post timber Russian mulberry is excellent, since the wood is exceedingly durable in contact with the soil. Its profuse branching habits, however, make it difficult to secure a large yield of posts. Its fuel value is relatively high, but the cordwood yield is low.

WHITE ELM.

White elm, tho one of the hardiest trees native to the State, does not have a very large place in economic planting, but in ornamental planting should have first rank.

The chief value of elm in economic planting is as a filler with such more useful trees as black walnut, catalpa, ash, honey locust, etc.

LOMBARDY POPLAR.

A large amount of lombardy poplar has been planted in Cache Creek Valley to prove up timber claims. Frequently also it has been set out in single rows. The tree succeeds unusually well in this region, making a good growth and showing no inclination to become stagheaded, as in the plains States. It should be planted guardedly, however, since it is quite generally a failure elsewhere in Nebraska.

BLACK LOCUST.

On account of insect enemies, black locust is an absolute failure in the territory covered by this investigation. Not one successful plantation was noted, altho the species has been planted to some extent in most of the region, especially in the southern counties. On account of the ease with which it may be propagated, its rapid growth, and its great durability in the ground, it is one of the most valuable of trees for forest planting wherever it will succeed, but at present it can not be recommended in eastern Nebraska. In parts of western Nebraska it succeeds fairly well. Near Paxton, in Keith County, are two splendid young plantations that were put out about 1891.

OTHER BROADLEAF TREES.

Hackberry, basswood, and bur oak are other species that are hardy for eastern Nebraska. The first two are rapidly coming into favor as street trees. Bur oak has high value both for posts and fuel, but on account of its slow growth its use in economic planting its limited. Wild black cherry may prove to be a useful tree for the region. It has made an unusually rapid growth on the station grounds at Lincoln in the eight or nine years it has been tried there, but whether it will be long lived is problematic. Coffeetree is a valuable species which may be planted with safety. Russian golden willow is proving hardy under Nebraska conditions. For windbreaks it is one of the best trees that can be planted. It is also very ornamental.

WHITE PINE.

White pine succeeds fairly well on the hard soils in the eastern counties, where it has been planted sparingly. Its range for planting is not determined. It will thrive for a number of years in any part of the territory, with the possible exception of the sand hills.

Plantation No. 1.—This plantation is situated on upland. The soil is a fertile prairie loam with a clay subsoil. The ground was thoroly prepared, and the young trees were planted in pure stand, 4 feet by 4 feet. Two or three open spots were left to give the grove a natural appearance. The trees were cultivated until they became large enough to form a ground cover. Later they were pruned, and still more recently two-thirds of the stand were thinned out, so that there are at present 916 trees per acre. No other attention has been given them. Further thinning will soon be required, however, since the stand is becoming crowded.

Excellent forest conditions for so young a grove have already been formed. The surface layer of humus is about 1 inch deep, and this is overlaid by a layer of litter 2 inches in depth, formed from the pine needles, twigs, and cones. There is no ground cover or underbrush within the body of the plantation.

The trees have grown remarkably, both in height and diameter. The sample dominant tree was 23.5 feet high, and the diameter breasthigh 4.6 inches. There are 68 trees per acre 6 inches in diameter, two 7 inches, and two 8 inches, and some are nearly 30 feet high. A height growth of 3 feet in a year is not uncommon.

AUSTRIAN PINE.

Austrian pine has been planted only to a limited extent in eastern Nebraska, tho probably as much as any other conifer except red cedar. Its use has been almost entirely as a lawn tree, and its success makes it safe to recommend it for this purpose.

JACK PINE.

Jack pine is adapted especially to planting in the sand hills. It is being successfully grown on the Dismal River Forest Reserve and by a number of ranchmen in widely scattered localities in the hills.

Experience shows that planting on north slopes gives the best results. South and southwest slopes are hotter, and the moisture conditions are not so good. Very dense sod should also be avoided. The different exposures that may be planted are, in order of suitability, the north, northeast, northwest, east, west, and southeast exposures, and, finally, the more level situations, such as valleys and crests of hills. The plan should be to plant blocks or belts of trees as windbreaks around the ranch house, barns, and yards.

WESTERN YELLOW PINE.

Western yellow (bull) pine and its variety, rock pine, are also being extensively planted on the Dismal River Reserve. They doubtless will be important factors in restocking the sand hills. Both do well on hard soils, and may be planted with safety thruout the region.

SCOTCH PINE.

Scotch pine is hardy on the heavy soils in eastern Nebraska. It has been planted mainly for ornament, and can be planted with safety for this purpose.

NORWAY SPRUCE.

Norway spruce has had a limited use in ornamental planting, and for this it can be recommended.

EUROPEAN LARCH.

One of the most promising conifers for economic planting is European larch. It has not been tested in Nebraska, but its success in Illinois, Iowa, Minnesota, and the Dakotas, where it has been given a thoro trial, warrants its use.

RED CEDAR.

Red cedar is native to the region and has been planted rather more extensively than any other conifer, but has been chiefly for protection and ornament. No tree makes a more effective wind-break when planted as a single row. It grows fairly rapidly, is hardy and long lived, and is as effective in winter, when protection is most needed, as at any other time. Branching is low, very dense, and persistent.

CONCLUSIONS.

No attempt has been made to exhaust the list of the trees suitable for planting in eastern Nebraska. Of those named, hardy catalpa, Osage orange, black walnut, cottonwood, white willow, green ash, and honey locust can be grown with profit, as the history of a specific plantation for each species shows. Hardy catalpa, Osage orange, green ash, and honey locust should be planted chiefly for fence posts, white willow for fuel, black walnut for lumber, and cottonwood for fuel and lumber. All attain their best development in rich, well-drained valleys. Cottonwood, white willow, and black walnut are essentially bottom-land trees. Osage orange should be planted on upland only in fertile soils in the southeastern counties. The range of hardy catalpa in upland planting is considerably wider, but it must have good soil. Green ash and honey locust are especially adapted for dry upland planting in the more western and southwestern counties.

Doubtless experience will disclose other trees that may be planted with profit. European larch, for example, is deserving of a thoro trial. In the sand hills some of the conifers, such as western yellow pine and jack pine, undoubtedly may be planted with profit, since land values are certain to remain low.

Approved,

JAMES WILSON,
Secretary.

WASHINGTON, D. C., *September 17, 1906.*

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